

AIR FORCE RESEARCH LABORATORY



**A Framework for Integrating
Cultural Factors in Military
Modeling and Simulation**

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EXECUTIVE SUMMARY

Effective and efficient culture cognition in the Future Force depends heavily upon orchestrating the cultural factors and patterns of battle information into effective cultural cognition models so that the appropriate context information is brought together at the appropriate time relative to the appropriate operational issues. At the heart of this problem lies the current inability of a commander (or his designated chief of staff, operations officer, information management officer, etc.) to know in real-time (1) what cultural factors will influence the outcome of a given mission and how these factors will influence this outcome (e.g., Iraq war) and (2) which of the cultural factors (e.g., political structural, religious, socio-economic, etc.) can be used by decision makers to control rhythms of war in their favor. Obviously, there is a need to address two challenges: (1) an understanding of how socio-cultural factors are likely to influence given military strategies and (2) an understanding of how to incorporate these factors into modeling and simulation techniques in order to optimize military personnel training. This paper presents an anecdotal literature review of cultural models and a framework for incorporating cultural issues in military simulations.

Chapter 1 presents the introduction to the scientific challenges of incorporating cultural modeling into military legacy systems. It is noted that cultural factors can manifest in many forms that include power distance, differentiation in socio-economic status, power struggle, and differential access to opportunities. A brief survey of culture definitions and their elemental factors are reviewed; the relevance of these factors to Coalition Task Force, Joint Task Force, and Effect-based Operations (EBO) are assessed. Salient among the identified factors are language, social interaction, and cognitive processes. It is argued that a cognitive approach to culture is usually not attainable simply because of the sparse information processing approach to culture definitions.

Chapter 2 presents some relevant cultural modeling paradigms. These are the view of culture as: (a) Integrated systems of ideas, learned patterns, and products of characteristics of a society; (b) A set of assumptions, beliefs, values, and norms that are shared by members of an organization; (c) Information transmitted among individuals and among generations by non-genetic means; (d) A cognitive process, dealing with information about experience—past, present, and the future; (e) An image reflecting how individuals and groups view their surroundings. Here, Beach's (1990) image theory is used to elucidate the major cultural image questions relevant to military applications.

Chapter 3 presents a deeper understanding of the important of cultural factors in military organizational modeling. Four kinds of knowledge or modeling abstractions are identified. First, Cultural Cognition based on Hutchin's (1991) paradigm is shown to be a powerful tool for developing cultural ontology for simulation modeling. Second, organizational knowledge and memory based on Nonaka and Takeuchi (1995) and Nisbett's (2003) geography of thought are viewed as tools for capturing a particular "culture memory." Third, Knowledge Mapping is analyzed as a model applicable to associating PMESII (Political, Military, Economic, Social, Information, and Infrastructure) to the strategic-based DIME (Diplomatic, Information, Military, and Economic) issues relevant to Effect-Based Operations and culture sensitive battle

systems. Finally, it is postulated that culture dimensions in adversary systems can be modeled by studying local conflicts engendered by urban gangs and civil rights strategies. This is to elicit ethnocentric experience for domain-specific simulation verification and validation.

Chapter 4 presents the impact of military hierarchy and stratification on cultural understanding and their relevance to training and doctrine developments. At the strategic level, cultural factors avail themselves in terms of understanding the national security of adversaries and one's own country, including evaluation of the DIME factors, stability factors, and higher order collectivism desired for Joint Task- and Coalition Task- Force formulations. At the organizational level, social, economic, and bureaucracy factors play the major roles. At the operational level, culture is shown to impact concepts of operation with the PMESII factors. At the tactical level, cultural factors are shown to influence the centers of gravity and the desired effects. The unity of rules of engagement, uncertainty, prejudice, and METTT (Mission, Enemy, Terrain, Time, and Technology) doctrines studied during courses of action development processes may reverse, depress, and/or compress the order of the battle plan. Another factor is political and is included as a consequence of Hofstede (1980) power distance, power struggle, and conflicts.

Chapter 5 presents cultural implications and frameworks to enable modeling and simulation of military systems with the inclusion of cultural factors. The framework includes the impacts of cultural perception of information—such as interpretation of signs, signals and symbols. This is further expanded for applications to war games and simulation applications by addressing four complimentary processes that include, the psychological processes of thinking and feeling—and social interaction process, risk perception and uncertainty management, dynamics of cultural evolution and the transition of values in time, and analogies and metaphor—using certain clichés that are rich in many cultures—proverbs, games, songs, plays, etc.

Chapter 6 presents the likely problems to be encountered by systems analysts in incorporating cultural factors into military modeling and simulation. These problems include, e.g., variations in cultural adaptability and interpretation, effects of dominant culture leading to skewed statistical distributions, variation in information abstraction - especially as they impact PMESII-DIME associations, and last, but not the least, issues of trust, validation and verification.

Chapter 7 presents a simple and constructive-based proof-of-concept (POC) model that simulates the number of time epochs for many cultures to attain cultural affinity based on their traits (chromosomes). Cultural affinity is hereby defined in terms of common understanding of cultures with specific reference to cultural traits. There are many available tools for this purpose—including, for example, Dawkins (1980) memetics, genetic algorithms, and dynamic simulations expressed in terms of physical equations. Genetic algorithms with a very simplified and home-breed fitness function heuristics were implemented with Mathlab. This program can be extended to study cultural games of different assumptions.

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CHAPTER 1

SCIENTIFIC CHALLENGES FOR CULTURAL MODELING IN MILITARY ORGANIZATIONS

1.1. Introduction

Recent military operations in Afghanistan and Iraq have illustrated the need for understanding cultural factors in military modeling and simulation. In the new Objective Force structure (<http://www.objectiveforce.army.mil>), effective collaboration is dependent on the reconciliation and integration of multiple operational perspectives across various organizational boundaries, various bodies of staff expertise, various sources of battle space information, and various battle rhythms. Modern conflicts are asymmetric and there is an increasing reliance on Joint Task Force or Coalition Task Force philosophies. A typical Coalition Task Force consists of multinational teams with heterogeneous cultures. Even teams with members from the same country may have cultural differences in the way they set up their operating procedures and doctrines in their various organizations (e.g. Air Force, Marines, Army, etc.). The enemy environment defines another type of culture that can be used as a soft weapon against a friendly Coalition Force. The on-going war in Iraq presents a picture of how culture has been used to control the pace of war. Remarkably, the Iraqis have used religion and language to define the rhythms of war, including new methods of deception. The Coalition Forces, led by the USA, are challenged with the daily tasks of learning the Arabic language, understanding the political and economic terrains, adapting to social structures, and so forth. The rising interest in fighting war with coalition forces creates a need for a much greater understanding of cultural knowledge.

Most existing research on culture and society has primarily focused on business settings, and especially on competitiveness (Trompenaars, 1993), business decisions (Schein, 1992), and information sharing (Veiga & Lubatkin, 2000). Results have revealed many causes that affect business and commerce competitiveness in transnational settings (Nisbet, 2003). Among these are: communication and language, value systems, religions and beliefs, security and risks, and fears of being absorbed by another culture. Military establishments have only recently begun to use the results from the business understanding of culture to control the personnel training in the military domain.

John Keegan¹, the eminent historian of warfare, argues that culture is a prime determinant of the nature of warfare. One of the most important lessons to emerge from the modern wars in Iraq, Afghanistan, Somalia, and Bosnia is the need to revise the training and development of our military leaders. Military leaders must be prepared for the ever-changing dimensions of war—stabilizing operations, civil duties, and emergency response operations, as well as participation in peace operations. For example, in the current Iraqi war, there are many instances in which Iraqi beliefs clash with the coalition's military culture. Some of these are: (1) a strong belief that Western style democracy is better than Islamic aristocracy; (2) a belief in the inferiority of all other groups' cultural heritage extending to the other group's customs,

¹ John Keegan, (2004). *The Iraq War*. ISBN 0091800188

values, traditions, and language; (3) a belief that a dominant nation has the power to impose its standards on another nation; (4) a belief that they are likely to lose their identity and right to exist as a nation—the enabling belief for the “America go home” syndrome.

These cultural differences are additional dimensions that must be considered in analysis of the effectiveness of our soldiers’ understanding of the adversary’s culture. As noted by Lt. Col. Higgins², culture has become the topic du jour in many circles of the DoD. There is a need to incorporate culture into the military planning process and formalize its process in shaping strategy.

1.2. Relevant Cultural Factors

The main objective of the Joint Task Force (JTF) is the transformation of the United State military force’s C2 decision-making capability into a presence with the capability of responding to adaptive adversaries around the world. Recent wars, such as Operation Enduring Freedom and Desert Storm, have demonstrated the relevance of joint interdependency and interagency/multi-national interoperability (Leedom, 2004). Moreover, the need to understand the Iraqi culture and the cultures of the international joint forces cannot be overemphasized. The DoD’s Vision 2020 and the Future Force doctrines require well-trained warriors who have a good understanding of the enemy’s culture as well as the cultures of the associates within JTF. Therefore, there is a need to understand how socio-cultural factors influence military strategies and to incorporate this understanding into modeling and simulation techniques. To begin this type of modeling exercise, a conceptual framework must be developed that is scientifically sound, robust, and rugged. Such a framework will depend on the existing body of knowledge, both in business and military organizations with dynamic data models and heterogeneous characteristics suitable for plug-and-play descriptive-normative simulation modeling. The initial challenge lies in understanding the military organizational culture.

The impact of cultural factors in JTF can more easily be recognized when the elements of these factors are integrated and made consistent with each other, particularly in high-consequence operations that risk human life. Figure 1 shows the cultural dimensions relevant to studying culture effects in military organizations—this example captures the generality of a Coalition Task Force model.

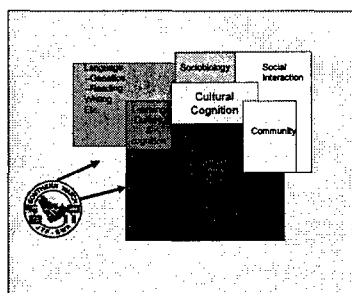


Figure 1. Cultural Interaction Model

² Culture shock: Overhauling the mentality of the military (Lt. Col. Beau Higgins), *UVA Alumni News*, Summer 2005

As shown in Figure 1, the cultural model generates various levels of interactions that form the guidelines for this literature review. These interactions are:

Language: This is the main characteristic of human and animal culture (Chomsky, 1972). Language can be acquired, inherited, and learned through written or spoken words. It is believed by Chomsky that tacit knowledge is culturally embedded in language and is how experts make themselves clear—communicating, expressing, informing, and arguing logically (e.g., Chomsky, 1972, pp. 103-104). Cultural traits vary in significance; they do so because of human language variations—each with variations in syntax, semantics, and other structures of language that bind a group of people together. These variations are somewhat, as a point of fact, controlled by the language structure—for example, each language structure must choose between case-suffixes and verb-agreement to perform the task of exhibiting the argument relations between verbs and nominals — subjects, direct objects, indirect objects. This is an implicit parameter, in written or spoken language that a system analyst must deal with. The misinterpretation of people intentions through spoken language are consequences of their grammar rules—an aspect of cultural embodiment.

Social Interaction: Culture is a by-product of the social interactions of special cohort groups who have intended goals such as military missions, or the preservation of ancestral ethos (Lumsden & Wilson, 1981). For some reason, society, at home (family) or at work, is often organized into predictable relationships—defining what is known as patterns of social interaction—the way in which people respond to each other. The behavior of each person is bound by rules, ethos, norms and other legislated behavior rules of the context society—although the individual is likely to form different interpretations of the situation, depending upon their unique experience, their unique organizational interests, and their unique roles and responsibilities within the overall system. If they are to cooperatively act in some cohesive manner, these individuals might come together in what some have termed a community of interest—a collaborative forum that holds a common interest in the operational work domain, leading to evolution of ethnocentric cultures and symbolic interactions—people with common ideology, believing that they are unique and are bonded together by a common cause. Thus, human beings act towards things, such as perceiving people, differently on the basis of the meanings they derived from their cultural surroundings.

Cognitive Processes: Culture is also viewed as a product of shared mental models through self- and group- situation awareness (Hutchins, 1991; Orasanu, 1990). Culture can be learned through various processes, including information transmission to a community of people through the use of sociobiological models or social network models (Burt, 1980; Colby, 2003). Cognitive psychologists³ have identified that the human species has cognitive abilities with relatively superficial individual variations, directed to members of its group or society with whom they interact, cooperate, and compete. For example, how people think (natively versus globally) or act (politely or aggressively). Among humans in particular, social life is richly cultural. Sociality and culture are made possible by cognitive capacities. These capacities span across many knowledge dimensions—moderating how we think, learn, adapt, discriminate, and decide, and so on.

³ D'Andrade, R. (1981). The cultural part of cognition. *Cognitive Science*, 5: 179 - 195

1.3. Selected Definitions of Culture

Many researchers have developed taxonomies to classify the cultures of the world. The following paragraphs summarize selected studies that purport to explain socio-cultural factors based on organizational theories.

Organizational culture is a concept often used to describe shared corporate values that affect and influence members' attitudes and behaviors. In response to the recognition that this culture has limitations in providing the 'glue' that holds organizations together, management over the last two decades has often focused on the concept of corporate culture. The dominating culture within any organization is usually based upon a blend of visionary ideas and is supported by ongoing analyses of organizational systems, goal-directed behavior, attitudes and performance outcomes. Although a universal definition of corporate culture does not exist, this culture appears to reflect shared behaviors, beliefs, attitudes and values regarding organizational goals, functions and procedures that characterize particular organizations (Furnham & Gunter, 1984). The main difference in the definitions of corporate culture appears to reside in their focus on either the way people think, or on the way people behave (Williams, Dobson & Walters, 1989), although some definitions focus on both the way people think as well as the way they behave (e.g. Margulies & Raia, 1978; Uttal, 1983).

Hofstede (1980, 1991) identified a four-dimensional model of culture that is useful for examining the effects of a heterogeneous culture on team decision-making (Handley and Levis, 1992). The first dimension in this model is Power Distance (PD). This dimension reflects the nature of leadership (i.e. consultative versus autocratic) and the acceptance of team members of unequal power relationships. It is defined by statements such as those indicating that juniors should not question the decisions or actions of their superiors. The second dimension is Individualism-Collectivism, which defines differences among individualistic cultures in which people define situations in terms of costs and benefits for themselves, and more collective cultures in which the focus is on the harmony within one's primary work or family group. For example, the concepts of teamwork and communication may be more easily achieved by collectivist cultural structures than by cultural structures with a more individualistic orientation. The third dimension, termed Uncertainty Avoidance (UA) is focused on the belief that organizational rules should not be broken. Different cultures respond differently to the unknown and employ different behaviors toward ambiguity. According to Hofstede's analysis, high UA cultures tend to be formally structured with clear distinctions among social roles. Organizations, institutions and relationships are highly structured so that people can easily interpret situations and understand their role and the expectations of them. In addition, high UA cultures encourage conformation and discourage "difference." By contrast, low UA cultures tend to allow more flexibility in social and personal relationships, encourage tolerance towards those who are "different" and show less fear of ambiguous situations. These patterns may have consequences on how teams make decisions. The fourth dimension is masculinity and femininity. This dimension focuses on the extent to which a society stresses achievement or nurturing. Masculinity is the trait that emphasizes ambition, acquisition of wealth, and differentiated gender roles. Femininity is the trait that stresses caring and nurturing behaviors, sexuality equality, environmental awareness, and more fluid gender roles.

Anthropologists Kluckhohn and Strodtbeck (1961) developed a framework of six dimensions to describe the value orientation of a culture. Value orientation represents how different societies cope with various issues or problems. In the Kluckhohn and Strodtbeck

framework, a culture may favor one or more of the variations or approaches associated with a particular value orientation. These orientations are: relation to nature, time orientation, basic human nature, activity orientation, relationships among people, and space orientation.

Trompenaars (1993), a Dutch economist, also developed a framework to examine cultural differences. Trompenaars described national cultural differences using seven dimensions. Five dimensions address the manner in which people relate to others, including universalism versus particularism, individualism versus collectivism, neutral versus affective, specific versus diffuse, and achievement versus ascription. The sixth dimension is time orientation: past, present, or future and sequential or synchronous. The final dimension is the relationship to nature: internal- or external-oriented. Just as with the Kluckhohn and Strodtbeck work, Trompenaars' dimensions represent how societies develop approaches to handling problems and difficult situations.

A different approach to understanding culture is the use of metaphors. The cultural dimensions described by Gannon and his associates (1994) can be derived from the symbolic metaphors of a society's everyday language. While explaining each metaphor, typical behaviors in the culture are likely to emerge. Schein (1992) noted that culture exists on three levels. On the surface are artifacts (the observable symbols, behaviors and practices). Underneath these artifacts lie values and cultural norms and at the deepest level core beliefs and assumptions reside. These basic beliefs and assumptions, which nurture and support the norms and values that members hold, are outside ordinary awareness and are often inaccessible to consciousness. The most accessible and visible elements of a culture- the artifacts, behaviors and practices- are viewed as furthest from the core of the culture. Viewed at a surface level, these artifacts can be seen simply as phenomena. When members of a group have a history of shared experience, and develop shared values and understandings that guide behaviors and practices, these phenomena have cultural significance. Schein (1992) believes that cultural study requires exploration of the shared beliefs, values, and knowledge that guide and direct observable practices, behaviors, and other visible cultural manifestations.

1.4. Summary of Contextual Definitions

Although there are several and different definitions of culture, their abstractions are often specific to observed societal information and behaviors. Tables 1 and 2 are used to summarize some of these cultural dimensions.

:

Table 1. A Summary of Cultural Dimensions

Cultural Factors	Author (reference)	Attributes
Power Distant (PD) Individualism-Collective (I-C) Uncertainty Avoidance (UA) Gender (G)	Hofstede (1980, 1991) (4 Factors)	Autocratic vs. consultative Individual vs. team UA : high, Low G: Feminity, masculinity
Nature (N) Time (T) Human (H) Activity (A) Community (C) Space (S)	Kluckhohn & Strodtbeck (1961) (6 dimensions)	N (internal, external) T(forward, backward) H (learning, status quo) A (Accepting, Opposing) C (Suspicious, Open) S (Tolerance, No tolerance)
Time (T) Nature (N) F1(Generality) F2 (Collaboration) F3 (Effect) F4 (Complexity/ Chaos) F5 (Goal/Intent/ Performance)	Tromperas (1993) 7 factors (Information in red are interpretative)	T (past, present, future) N (Internal, external) F1 (universalism, particularism) F2 (Individualism, collectivism) F3 (Neutral, affective) F4 (Specific, diffuse) F5 (Achievement ego, ascription ego)

Cultural Factors	Author (reference)	Attributes
Symbols (Sy) Behaviors (B) Religion (R) Values (V) Norms (No) Beliefs (Be)	Schein (1992) 6 factors	No specific atomic attributes
Others: Morality Bias Rituals Technology Ideologies Education	Various documentation in socio-cultural literature	

Table 2. Four Types of Culture in Organizations (Handy, 1993)⁴

Type	Metaphor	Characteristics
Power Culture	A web	Control/ power emanate from the centre; political power and entrepreneurial energy, resource power and personal power predominate. This culture serves the figure head and the leader.
Role Culture	A Greek temple	Classical structure; bureaucratic nature; roles more important than the people who fill them; position power and expertise power predominate. This culture serves the structure.
Task Culture	A net	The focus on completing the job; individuals' expertise and contribution are highly valued; expert power predominates, but both personal and position power are important; the unifying force of the group is manifested in high levels of collaboration.

⁴ Handy, C. (1993). *Understanding Organizations*, 4th Edition. Penguin Business

Person Culture	A cluster or galaxy	A loose collection of individual-- usually professionals—sharing common facilities but pursuing own goals separately; power is not really an issue, since members are experts in their own right. This type of culture serves the individual.
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CHAPTER 2

SOME RELEVANT CULTURAL MODELING PARADIGMS

2.1. Important Modeling Paradigms

Paradigm is a way of organizing and condensing domain specific information. Paradigms also affect the way we design, record, and interpret our experiments and observations, as scientists and as humans. In this report, paradigms are used to guide us to sort, organize, and classify information that is available in the literature with bias towards application to representation for modeling and simulation.

As mentioned before, culture, by definition, is multifaceted and is primarily anchored in the context of how a group of people define themselves. For this reason, it has been studied by anthropologists, sociologists, psychologists, management scientists, and recently, cognitive scientists are trying to study it from information processing perspectives. Given the complexity of cultural factors and the large number of elements that must be considered in its study, it is apparent that we must seek ways of organizing and, to a degree, simplifying what is available in the literature to make it relevant to the simulation and modeling community. To do this we must understand the existing modeling paradigms— the specific arrangement of constructs and processes designed to define culture in context. The literature review highlights at least four important paradigms for cultural modeling (listed in the next four sections).

2.2. Culture is an integrated system of the ideas, learned behavior patterns, and product characteristics of a society (Hierbert, 1983)

This view supports the fact that organizational memory can be developed with culture as its center of gravity (Nonaka & Takeuchi, 1995). This is an organizational view of culture. Schein (1985) considered it in terms of three levels of modeling abstraction, each distinguished by their visibility and accessibility to individuals (Figure 2). As illustrated in Figure 2, the model explains organization culture as a pattern of basic assumptions which a group has invented, discovered or developed in learning to cope with its problems of external adoption and integration, which have worked well enough to be considered valid, and therefore to be taught to new members as the correct way to perceive, think and feel in relation to problems. In Figure 2, the system value and basic assumptions are located at Schein's second and third levels and are invisible, preconscious and 'taken for granted', and are often difficult to access.

2.3. Culture is a set of assumptions, beliefs, values, and norms that are shared by members of an organization

Each cultural dimension can metaphorically represent the spatial location of individuals and group thinking in a trajectory of social norms (Nisbett, 2003). In his book, Nisbett observed that East Asians and Americans responded in qualitatively different ways to the same stimulus situation. In one experiment, designed to test whether East Asians are more likely to attend to the whole while Westerners are more likely to focus on a particular object within the whole,

Japanese and Americans viewed the same animated underwater scenes, then reported what they had seen. This kind of observation is not isolated and has been paradigmatically assigned to cause-effects attributed to assumptions about our beliefs, values, and norms. The organizational values are formed by extracting relevant information from the environment and the workers in the corporate settings. The value statements form the order of conducting business. The

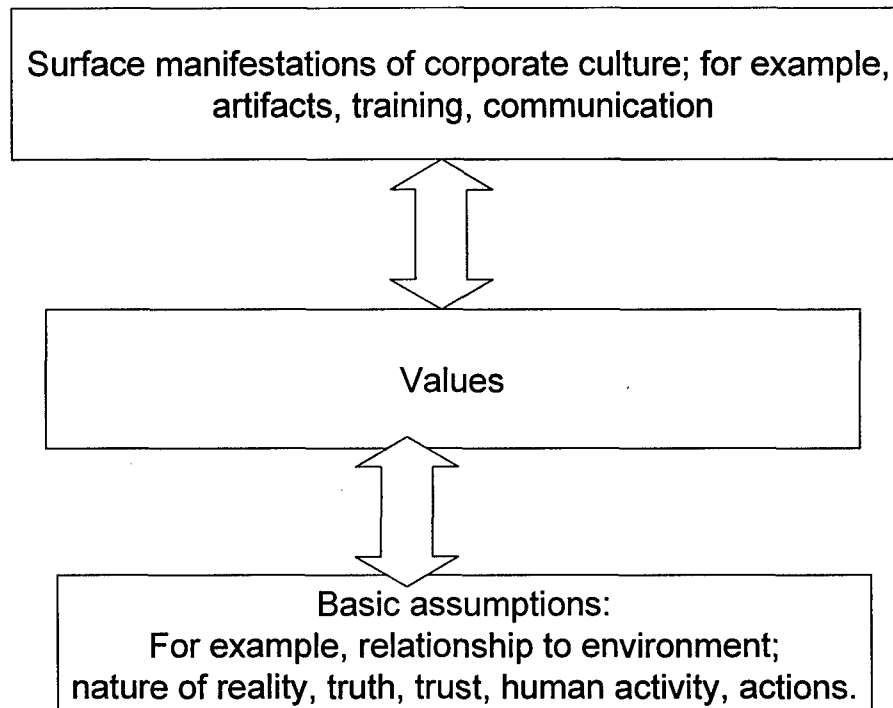


Figure 2. Schein's Three Levels of Culture⁵

value statements, for example, in the military, are described in terms of doctrines—the military values-- such as duty, integrity, courage, loyalty, and selfless service. These dimensions are expressed by Confucius as **"Know thyself, know thy enemies."** **"In a thousand battles, win a thousand victories."** This view represents the normal process of modeling complex systems—assumes certain relationships, reduces non-linear systems to programmable linearity, divides and conquers, and subsequently synthesizes all of these elements (Mitroff & Kilmann, 1975; Koomen, 1985).

2.4. Culture is any information transmitted among individuals and among generations by non-genetic means (Spector and Luke, 1996; Bonner, 1980)

This is a computational view that assumes that culture can be represented as a system of symbols (Boyd & Richerson, 1985). The major focus of symbolic assumption of culture can be attributed to Geertz⁶ who defines culture as "an historically transmitted pattern of meanings embodied in symbols, a system of inherited conceptions expressed in symbolic forms by means

⁵ Schein, Edgar H. (1985). *Organizational Culture and Leadership*. San Francisco: Jossey-Bass.

⁶ Geertz, Clifford (1973). *The Impact of the Concept of Culture on the Concept of Man*. In: *The Interpretation of Cultures* (pp. 33-54). New York: Basic Books, Inc.

of which men communicate, perpetuate, and develop their knowledge about and their attitudes toward life.” Studying culture as a symbol allows us to capture the ways in which people understand and interpret their surroundings as well as the actions and utterances of the other members of their society. These interpretations form a shared cultural system of meaning, i.e., understandings shared symbols, to varying degrees, among members of the same society⁷. Cultural symbols can take several forms, including, myth and ritual by which humans assign meanings to these symbols in order to address fundamental questions about human social life. In this way, culture is expressed by the external symbols that a society uses rather than being locked inside people's heads. These symbols are for “secret or tacit” communication by specific groups who remain anonymous to their secret code of practice. Exhibit 1 shows example symbols by American gang groups in an urban setting.



Exhibit 1. Illustrations of Gang Symbols and Signs

2.5. Culture can be interpreted in the context of cognitive process since it is the process of dealing with information about the past, the present, and the future (Brown, Collins & Duguid, 1989)

People everywhere must process information and this phenomenon represents a universal need for cognition and culture. Cultural cognition is the imperative for team situation awareness (Endsley, Bolte, & Jones, 2003), and team mental models (Hutchins, 1991). This stance argues that the individual is a sensor and information processor, and collectively, the society or group having the same “mind” orientation and shared knowledge, and they agree on a “common framework.” For example, issues of gun control, abortion, and other politically sensitive issues are decided in part as a result of consensus enabled by collective culture cognition. Here the individual or collective mind is viewed as a rational information processor. As a cognitive process, culture carries with it many types of biases, for example, emotion,

⁷ Des Chene, Mary (1996). Symbolic Anthropology. In *Encyclopedia of Cultural Anthropology*. David Levinson and Melvin Ember (Eds), pp. 1274-1278. New York: Henry Holt

prejudice, and atypical beliefs⁸. Cognitive scientists and cultural theorists traditionally have thought about the interface of culture and cognition quite differently. From a cognitive science perspective, the study of culture typically is construed as the search for those aspects of artifacts and past experiences that are uniformly true for all, assuming that all normal human beings are equipped with the same set of ecological background that includes perceptual, memorial, learning, and non-logical inferential procedures.

2.6. Culture as a Society Image

The basic premise of images is that the world is too complex a place to allow everyone to be identified in a unique way, and therefore people or groups of people attempt to define their image through established cultures. Images, whether accurate or not, are an important parameter when decision makers determine how to deal with situations, e.g., acting. Thus, in some way, perceptions or images necessarily influence action. The battlefield environment and the commander's decision is no exception.

Beach (1990) emphasizes five concepts relevant to image theory: images, framing, adoption, progress, and deliberations. Image theory views the decision maker as employing three types of images that partition one's decision-related knowledge. The first image is the *value image* which defines how events should transpire in light of the decision-maker's values, morals, ethics, and so on. The second image is the trajectory image which consists of an agenda of goals and related time-lines for accomplishing them. The third image is the strategic image which includes general plans and specific actions and how well the plan is to be accomplished. The hierarchical decomposition of these images can be relevant to understanding cultural factors in a military domain. This can be achieved through a series of question-answer morphology. Figure 3 is one such method of decomposition—one organized around the basic operational questions that would be asked by a commander—and one likely to play out in training and simulation exercises.

⁸ Tversky, A. & Kahneman, D. (1973). Availability: a Heuristic for Judging Frequency and Probability. *Cognitive Psychology*, 5, 207-232.

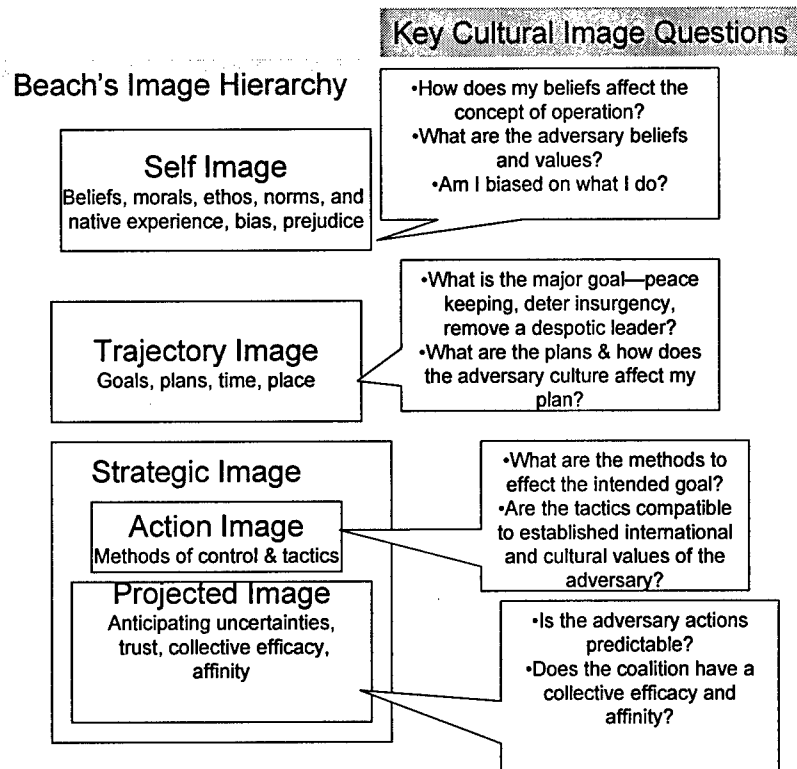


Figure 3. Beach's Image Theory for Culture Knowledge Capture

CHAPTER 3

IMPORTANT CULTURAL FACTORS IN MILITARY ORGANIZATIONAL MODELING

Given the multifaceted, multidimensional definitions of culture, it is important to identify and formulate our understanding of these definitions in the context of modeling and simulation in context. This chapter presents reducible forms of the existing paradigms and shows their relevance to military modeling and simulation applications.

3.1. Cultural Cognition Model

Culture is not limited to countries or nations. Even two people who share a life together can create their own culture. They can have customs, traditions, stories, and beliefs that bind them and give meaning to their life together. Cultural cognition models capture these attributes and deal with the locus of knowledge that is held individually and externally based on the society's dictated modus operandi and the methods used by individuals to share their mental models with other members of the society. Samples of these methods include analysis of language, quasi-analytical models of beliefs, and conflict resolutions (Bibby, 1992; Brown, Collins, & Duguid, 1989; Tomassello, Kruger, & Ratner, 1993).

Cultural cognition is the study of what people can say about what they know (Hutchins, 1991). An example of a cultural model used in capturing team knowledge is story telling. Storytelling is a commonly recognized method for communicating visions, strategies, structures, identities, goals, and values within both organizations and cultures (Denning, 2001; Swap, Leonard, Shields & Abrams, 2001). Stories also represent a powerful mechanism for communicating themes and evoking visual images (Morgan & Dennehy, 1997).

Signs, symbols, and signals also serve as artifacts of cultural identity and cognition. Figure 4 illustrates how the popular peace symbol is interpreted in Iraq and USA. With a good understanding of cultural cognition, it is possible to affect the C2 modus operandi in a military coalition setting. For example, the decision makers will cope and appreciate the various types of organizational ignorance that may occur as a result of interpreting different cultural characteristics. Examples of this ignorance (*also can be construed as trainable factors*) may include:

- A lack of sufficient information to make decisions due to situation uncertainties.
- Bias that tends to sway decisions in one direction.
- Multiple, competing frameworks to interpret the relevance of cultural information (explanatory equivocality).
- Limited insights on the effect of cultural implications.
- Cultural models that govern the ways people interpret their experiences and guide actions in a wide range of life domains. An especially important type of cultural model is a script (Schank & Abelson, 1977). A script is an event schema that stipulates the people who appropriately take part in an event, the social roles they play, the objectives they use, and the sequence of actions they engage in. (Nisbett & Norenzayan, 2002, p.6).
- The schema notion helps to organize and explain the radical differences in the contents of human minds across cultures.

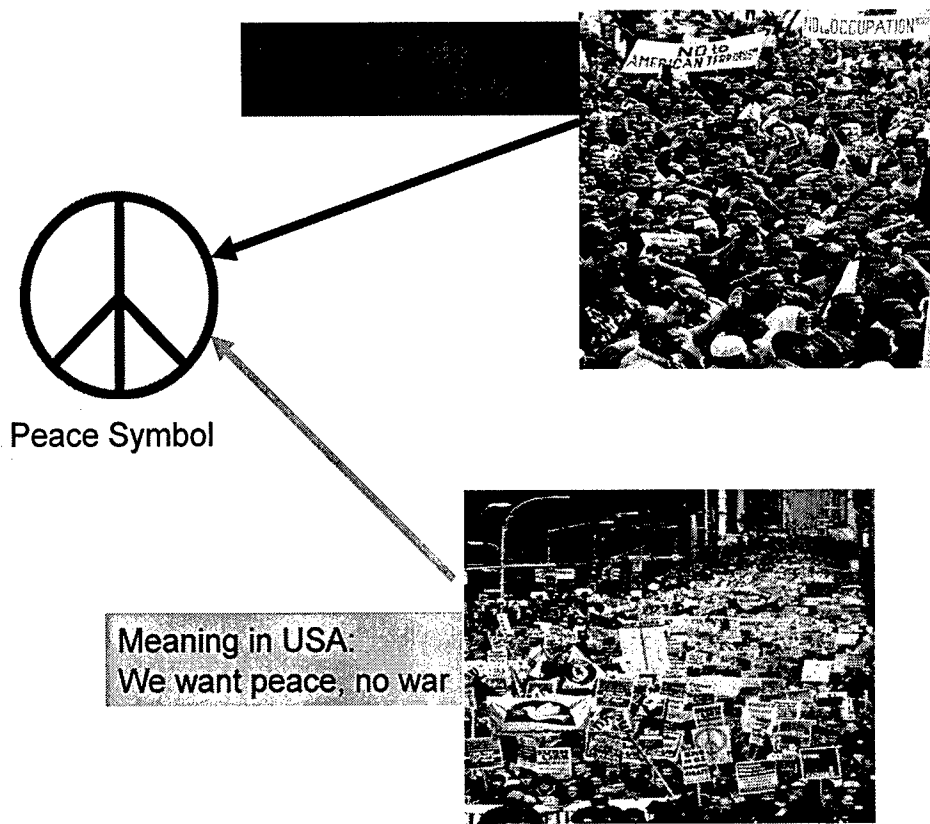


Figure 4. Cultural Cognition of Peace Symbol

3.2. Organizational Knowledge-based Model

Organizational culture is the set of assumptions, beliefs, values and norms that are shared by organizational members. Each dimension can metaphorically represent the spatial locations of individual and group thinking in the trajectory of social norms (Nisbett, 2003). This culture may have been consciously created by its key members, or it may have simply evolved across time. The culture represents a key element of the work environment in which employees perform their jobs.

The issues of organizational knowledge acquisition and storage as organizational memory have been widely recognized in the business domain. Nonaka and Takeuchi (1995) have suggested that knowledge is created through four different modes: (1) socialization, which involves conversion from tacit knowledge to actionable knowledge, (2) externalization, which involves conversion from tacit knowledge to explicit knowledge, (3) combination, which involves conversion from explicit knowledge and (4) internalization, which involves conversion from explicit knowledge to tacit knowledge. In developing a framework for a socio-culturally-based simulation environment, the dimensions of organizational knowledge are relevant—for ones need to observe the overall effect of current information and lessons-learned. Figure 5 below shows the configuration of a Coalition task Force memory and the overall impacts on what culture to respect in the early part of Iraqi war. At least four observations can be made:

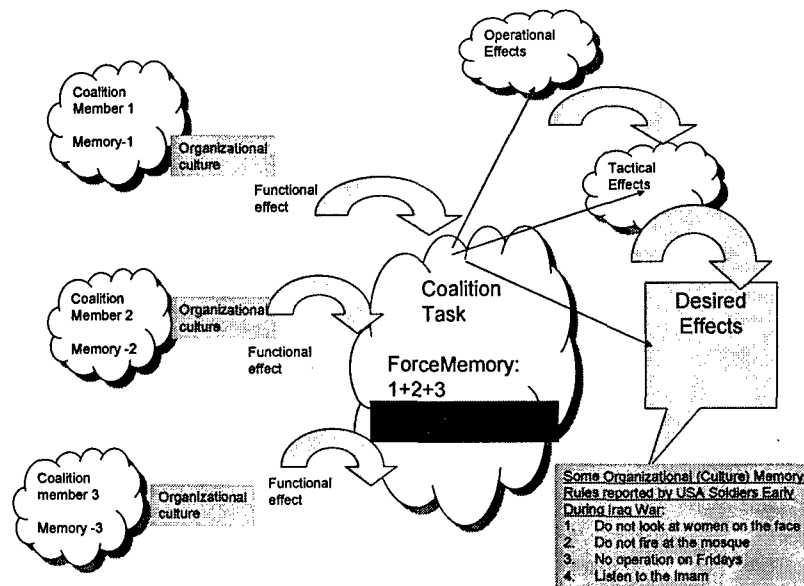


Figure 5. Coalition Task Force Cultural Memory

- Organizational culture is a strong force—one that may hinder the implementation of knowledge management in an organization (Ladd & Heminger, 2002).
- Specifically, organizational culture may affect an organization's ability to transfer knowledge because a culture may encourage individuals either to resist searching out and receiving knowledge or to resist efforts to move knowledge out of their heads.
- An organization whose members' interests are diverging can expect less knowledge to be transferred than one whose members have converging interests. A diverging of interests appears to increase the likelihood of self-serving behavior at the expense of overall organizational performance—because individuals either do not understand how organizational performance benefits them personally, or do not care.
- From an organizational perspective, the collective values and beliefs of the individual members of an organization represent an organizational culture. These values and beliefs constitute a pattern of basic assumptions held by the people in the organization that is used to address the problems of adaptation and integration.

3.3. Knowledge Mapping

Both cultural cognition and models of organizational memory have been found to be crucial in modeling socially motivated collaborative systems (Barney, 1985; Burt, 1980; Monge & Contractor, 2003). Moreover, these elements depend on the structure of the social group culture (SGC). Implementation of SGC information by a computer may require more sophisticated complex computer coding such as that presented in Dawkin's meme (Dawkin, 1982). Complexity may arise as a result of information integrated by functions, operations, and the activities the subsystem is supposed to perform. Here, many characteristics of complex systems are sure to arise. For example, (a) a possibility of self-organization—to influence each other and be influenced in turn, and (b) co-evolution—the ability to create a completely new

culture thereby influencing the development of new doctrines, operating procedures, and so on through emergent behaviors. A good deal of implicit knowledge is needed to validate simulation models, especially when there are transitions from a system of subjective symbols to quantitative representations. This type of mapping is responsible for hesitations in the application of genetic algorithms or neural network models to cultural algorithms (Cavalli-Sforza & Feldman, 1981). It creates boundaries and constraints to the system engineer.

The issues of knowledge mapping can well be illustrated in the model of effect-based operations requiring the concept of PMESII (Political, Economic, Military, Social, Information, and Infrastructure) and DIME (Diplomatic, Information, Military, and Economic) as shown in Figure 6.

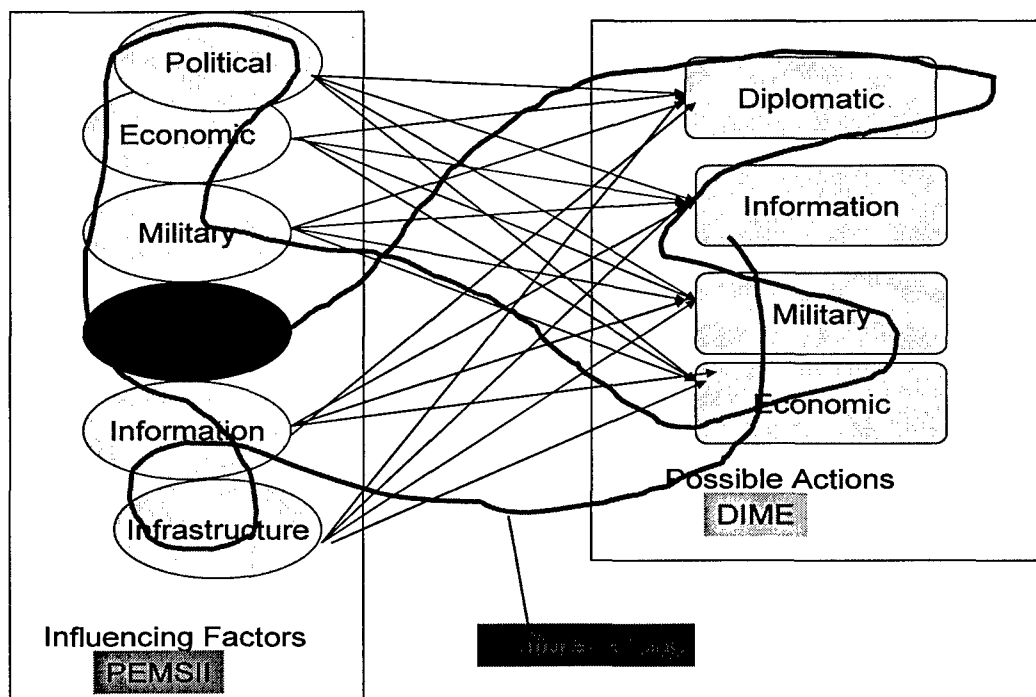


Figure 6. Sample Knowledge Mapping for PMESII and DIME

Implementing Effect-Base Operations (EBOs) within a culture-centric paradigm is linked to the mission and Commander's intent which in turn can be analyzed in a "System of Systems Analysis" (SoSA) that characterizes the network nodes as political, economic, military, social, infrastructure, or information - PMESII, in the EBO lexicon. The knowledge mapping network associates information elements of the PMESII nodes through a combination of diplomatic, information, military, or economic (DIME) efforts. These efforts can be linked to the desired effects on each node, appropriate to the plan.

3.4. Eliciting Ethnocentric Experience

Knowledge in an organization can be either captured explicitly or tacitly. Captured knowledge is placed in a form that makes it useful to others in the organization. Explicit knowledge consists of those things that individuals know that they know. Both captured and explicit knowledge are easier to deal with and are often tackled first in a knowledge project

through solutions such as document management systems or skills' databases. Tacit knowledge is the most difficult to tap into and utilize. While often neglected in knowledge management systems, tacit knowledge is probably the most important type of knowledge at an organization's disposal (Cavalla-Sforza & Feldman, 1981). Capturing tacit knowledge is another challenge in developing a cultural-based simulation model.

We can use urban gangs to illustrate the essence of knowledge elicitation—either through analogical reasoning or through direct observation. The urban environment is a complex setting, one in which the social and physical elements are governed by political forces affecting all areas of a family's experience. Gangs have similarities to military adversaries because of the following (Figure 7):

- operating as insurgents,
- committing certain violent crimes,
- bonding in the pursuit of common goals, and struggling to survive in times of economic uncertainty.

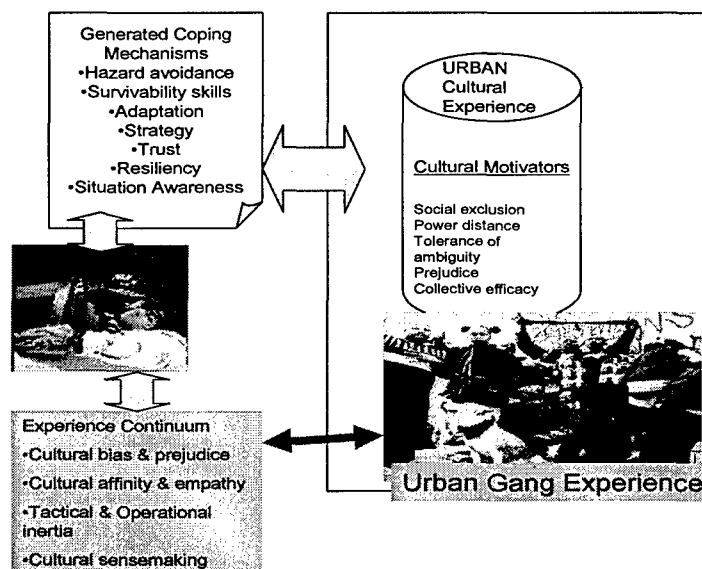


Figure 7. Urban Gang Cultural Experience for Military Training

It is posited that racial and ethnocentric experiences (cultural identity) of USA soldiers in urban living have some statistical characteristics reminiscent of areas of modern military conflicts in Afghanistan, Bosnia, Somalia, and Iraq. Similarities can be drawn between urban city gangs in America and insurgents in Iraq.

Such gangs as the Crips and Bloods of Los Angeles and the United Blood Nation of New York are examples. These groups develop through mutual interests and have specific behaviors such as unreflective internal structure, esprit de corps, solidarity, group awareness and attachment to local territory.

CHAPTER 4

MILITARY HIERARCHY AND STRATIFICATION OF CULTURAL FACTORS

4.1. Synopsis

The military organization is traditionally designed based on three levels of C2 abstractions: strategic, operational, and tactical. This kind of design assumes information to flow down along the echelon of command. It is therefore natural that the cultural factors be understood at these levels of command hierarchy. This is noted by Secretary Donald H. Rumsfeld (www.defenselink.mil/news/Mar2005/d20050330roadmap.pdf) when he observed as a matter of fact that “foreign language skill and regional and cultural expertise are essential enabling capabilities for DOD activities in the transition to and from hostilities.”

In brief, we will now discuss the implications of cultural factors to the three echelons of the military hierarchy, including the power of culture and their training needs. Figures 8 and 9 are used to illustrate this. Figure 8 is a conceptual formalism. Figure 9 illustrates the applications for modeling formalisms.

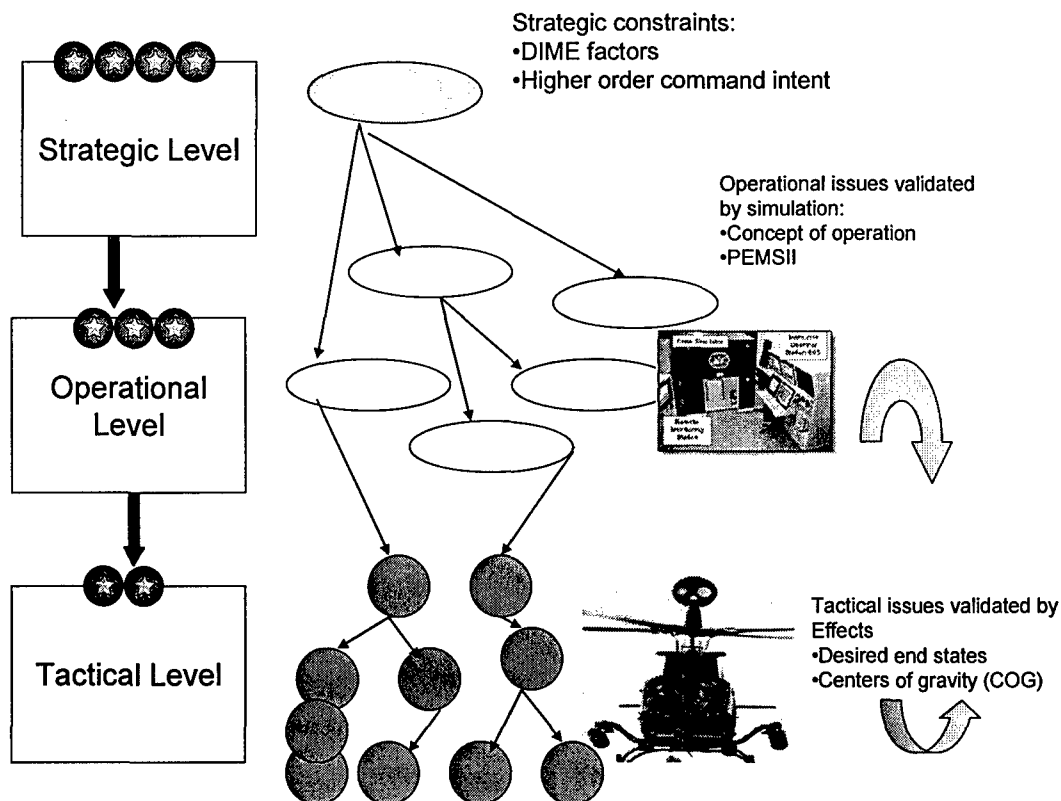


Figure 8. Cultural Factors at the Echelons of Military Hierarchy

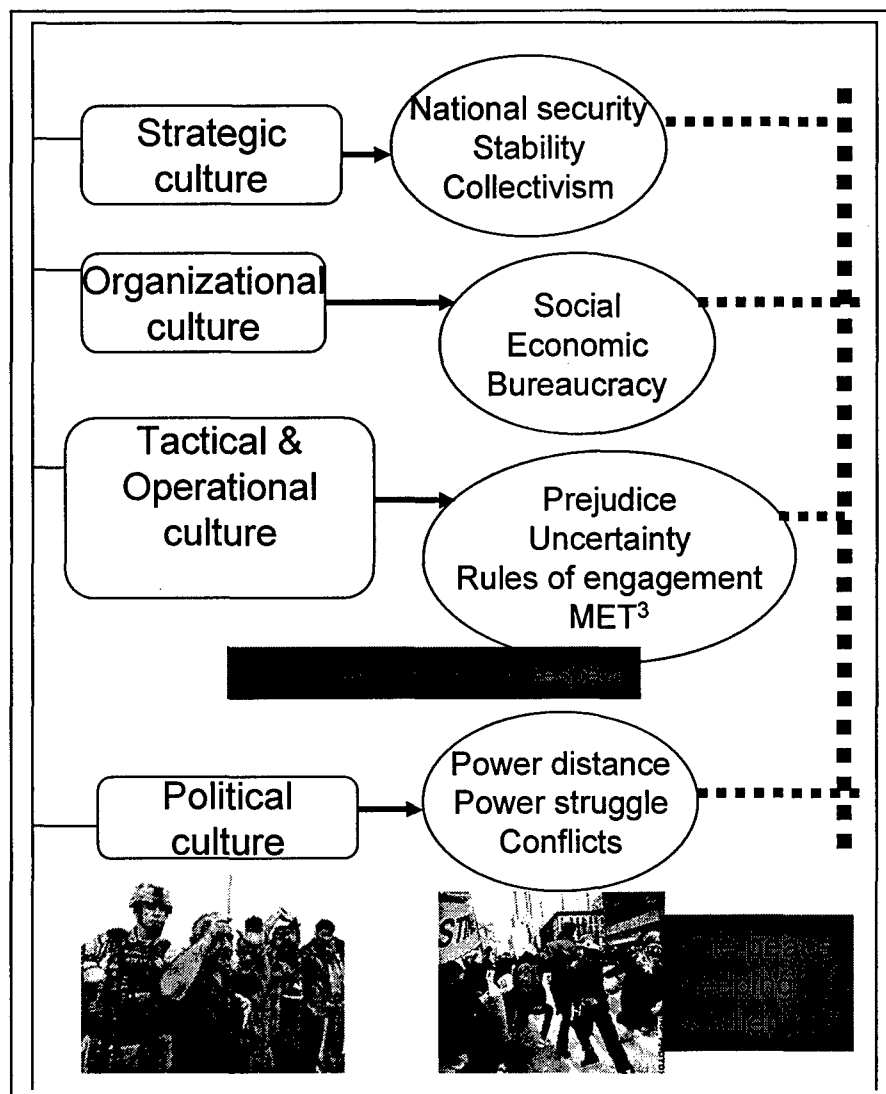


Figure 9. Sample Information Abstraction for Culture Training

4.2. Strategic Culture Understanding

At the strategic level, it is important to know how national regimes and adversaries think about defense and security issues. It also involves the selection of coalition partners, including collective and shared intelligence on the adversaries. The DIME factors would typically reflect the training at this level. Strategic culture according to Sten⁹ can be best defined as “the sum of ideas, conditioned emotional responses, and patterns of habitual behavior that members of a national strategic community share with regard to nuclear strategy”. Strategic culture is compatible with notions of limited rationality where one nation tries to intuitively game-play

⁹ Rynning, Sten (2003). The European Union: Towards a Strategic Culture? *Security Dialogue*, Vol. 34 (4): 479-496

the behavior of the opponents (adversaries) or even a friendly nation. Usually, a nation, often as a member of a group of nations, determines national or multinational (alliance or coalition) security objectives and guidance, and develops and uses national resources to accomplish these objectives. Activities at this level establish national and multinational military objectives; sequence initiatives; define limits and assess risks for the use of military and other instruments of national power; develop global plans or theater war plans to achieve these objectives; and provide military forces and other capabilities in accordance with strategic plans. This level of war is divided into strategic-national (DOD/Service/interagency) and strategic-theater (combatant command) to provide clarity and focus for task development and execution.

4.3. Organizational Culture Understanding

The constraints and incentives set by social and economic structures shape organizational cultures. For example, if the USA military must win war against the adversaries, they must know the military cultures of the adversary regimes, and environments harnessed by ethnocentric consciousness. For example, knowledge of bureaucracy and the government working machineries are salient to logistics operations of coalition partners during war time. The organizational culture can best be understood in terms of the abstraction of means-ends analysis—which typically attempts to define the individual and the collective roles in context of the work domain¹⁰.

4.4. Operational and Tactical Culture Understanding

At the tactical level, cultural understanding provides the basis for simulating actionable knowledge, including, the desired effects. Commanders and their staff should understand how to use the adversary's culture to develop a concept of operations that includes courses of action developments that consider the mission, enemy, terrain, troops, and technology. The anticipation of surprises and other forms of uncertainties can easily be detected through the cultural lens of the adversaries based on the footprints of past conflicts—whether local (such as ethnic conflicts) or insurgents. The cultural lens can portray many dimensional factors that affect the conduct of operations or rules of engagement. For example, prejudice, bias, ethnicity, power struggle, and so on.

The operational level of war is where campaigns and major operations are planned, conducted, and sustained to accomplish strategic objectives within theaters or areas of operations. Activities at this level link tactics and strategy by establishing operational objectives needed to accomplish the strategic objectives, sequencing events to achieve the operational objectives, initiating actions, and applying resources to bring about and sustain these events. These activities imply a broader dimension of time or space than do tactics; they ensure the logistic and administrative support of tactical forces and provide the means by which tactical successes are exploited to achieve strategic objectives. These activities, therefore, must consider the aspects of the adversary's cultural dimensions.

The tactical level of war is where battles and engagements are planned and executed to accomplish military objectives assigned to tactical units or task forces. Activities at this level

¹⁰ Rasmussen, J., Petjersen, A.M. & Schmidt, K. (1990). *Taxonomy for Cognitive Work Analysis*. Roskilde, Denmark: Riso National Laboratory.

focus on the ordered arrangement and maneuver of combat elements in relation to each other and to the enemy to achieve combat objectives. The anticipated effects on the adversary's culture and social life remain the most costly aspect of war.

4.5. The Politics of Culture

This is particularly relevant to coalition forces and /or internally to a Joint Task Force of nations similar to the USA whose independent establishments, like the Air Force, Army, Navy, and Marine, may be operating with different doctrines and standards operating procedures (SOP). The politics of power plays out as a hindrance by limiting the opportunity to achieve consensus. This effect can be attributed to many factors, such as lack of shared mental models, lack of shared situation awareness, lack of shared leadership, and emergence of power struggles.

CHAPTER 5

CULTURE IN MILITARY ORGANIZATIONS: IMPLICATIONS AND A FRAMEWORK FOR SIMULATION APPLICATION

5.1. Caveat

The main differences in the definitions of culture reside in the way people think, and/or the way people behave (Bourdieu & Passeron, 1990). Culture is heterogeneous when it involves people of various backgrounds interacting. It is homogeneous when people share common beliefs, attitudes, and values. Although the belief and values of an organization can be common, its function or purpose can vary from division to division, department to department, workgroup to workgroup, and individual to individual. Different sub-cultures, therefore, emerge from, or form around, functional groups, hierarchical levels and corporate roles with very few values, beliefs, attitudes or behaviors commonly shared by the whole corporate membership. On the basis of these phenomena, mathematical models have been used to represent organizational behaviors (Sandoe, 1998). These models are a corpus of frameworks that are amenable to symbolic programming by a computer.

Organizations can also develop specific cultures that affect their performance. For instance, in the context of JTF, diverse cultures must be shared and used to support the decision-making process. Strategically, the enemy's cultural traits remain important ingredients for understanding the evolving behavior in asymmetric warfare environments. For example, in effect-based operations (EBOs), the focus is on prolonged, low conflict actions, with direct attack on will, either during peace, crisis, or war-time (Smith, 2002). Thus, EBOs are not simply a mode of warfare. They encompass the full range of actions that a nation may undertake to induce a particular reaction on the part of the opponent, ally, or neutral entity (Smith, 2002, pp. 47).

While military organizations are increasingly recognizing the importance of socio-cultural factors in military planning and intelligence sensemaking processes (Handley & Levis, 2001), a challenge lies in adopting active approaches to defining cultural identity, preserving it in the organizational knowledge base, and using it to drive simulation and training. This notion makes the current approaches to military organizational modeling and simulation less useful for the training of modern military personnel. There is a need for innovative approaches to creating a resilient, robust, and dynamic framework for simulation that complements or extends beyond the existing high level architecture (HLA) considered standard for the military. However, despite its relevance, organizational culture remains rather ill defined and rarely used in constructive-based simulation models.

5.2. A Framework for Cultural Factors in Organizational Model

The characteristics of organizational culture are important to organizational performance. These characteristics are, in part, based on a taxonomy of cultural concepts including, but not limited to, (Brooks, 1994): artifacts- such as espoused values; symbols (e.g.,

language), food and religion; organizational structure; leadership styles; power dimensions; environment and technology; attitudes towards time, environment, uncertainty, and strangers; beliefs-(e.g., gender roles in the society); socio-economic factors, and political factors- (e.g., government and ideology). Other factors include war, migration, ecological crisis, economic crisis, and terrorism. A researcher can use this taxonomy to study two opposing factors. For example, the reductionistic versus holistic models; and, particularism versus universalism models. In the reductionist view, a divide and conquer approach is often the rule of thumb (Schein, 1992), whereas, the holistic approach considers complex interrelations in the organizations. In the particularism¹¹ model, behaviors of individuals in the organizations are observed and analyzed. Here, the goal is to improve the individual performance. For example, individual soldier training is often conducted to gain insight on motivation, fatigue, and so forth. From the universalistic view, soldiers are trained as teams to work collaboratively towards a single mission or goal.

5.3. Signs, Signals, and Symbols: The Impacts on the Cultural Perception of Information

The factors representing the C2 elements can manifest themselves in the form of signs, symbols, or signals used in military communications. This situation poses a problem with standardization in the military modeling and simulation domain, where, for example, different symbols may mean different things to different coalition members. Thus, a coalition member's attention is turned to differences among the entities at the same level of analyses (e.g. the symbols or signals). Symbols at the same level may indicate that the locus of culture is situated and they may influence the C2 process at, in the least, two complimentary levels of knowledge:

- (i) Team situation awareness. All elements in the organizational structure have the same operational model of the battle space.
- (ii) Cultural cognition. Members of the organization, with diverse and heterogenous cultures, must develop a common cultural cognition to embrace some aspect of an individual culture. This situation occurs most commonly with the increasing use of coalition forces from different friendly nations.

5.4. War Gaming and Simulation Applications

War games are the center of gravity of military training. However, very few of the war games use cultural factors. Future Forces war games and simulation models must consider the cultural dynamism defined by various effect-based factors that may capture the parameters of the individual coalition factors or cultural actors. Some of the relevant factors are:

1. The Psychological Process: Culture is shaped by both psychological processes that determine how people think and feel, and social processes that determine how people interact ((Henrich & Boyd, 2002). *This knowledge is fundamental in designing human-computer interaction for simulation models.*

2. Cultural Differences and Risk Perception: Cultural differences affect our judgment and risk perception in a context task (Hsee & Weber, 1999). Hsee & Weber (1999) concluded that more

¹¹ Leedom (2004)

Chinese than Americans take financial risks, and hence, are more culturally risk-seeking; on the other hand, more Americans were found to be more risk-seeking in social variables. *These findings suggest that simulation models need to include risk perception as a component of the performance factors, especially, when coalition warfare planning is at stake.* For example, most people exhibit nativist thinking (i.e., they think in terms of their specific culture). At the other end of the spectrum are people who think empirically through learning and inference.

3. Dynamics of Cultural Representations. Simulation models must establish culturally available schemata (CAS) where everyday cognition applied to decision making relies on a situational context (Schank & Abelson 1977). With schema, knowledge structures that represent objects and events can be represented, and it is possible to provide default assumptions about their characteristics, relationships, and entailments under conditions of incomplete information – (D'Andrade, 1995). *The military legacy systems, standard operating manuals (SOP), training manuals, and doctrinal handbooks have invariants of embedded cultural factors that in one way or another tend to capture organizational beliefs, ideas, mental models, shared behaviors, attitudes, and values.*

4. Analogies and Metaphors in System Modeling: In reality, modeling and simulation are analogies of real systems that are represented metaphorically by derivative languages and symbols amenable to computation. Hofstadter (in Godd, Escher, Batch: An Eternal Golden Braid) notes that ants share a single, largely genetically structured set of goals and a single plan. *In the same analogy, culture can be seen as an organizational goal, or, as constraints that control the performance of the organization. Culture can be a single, largely unstructured commander's intent that is governed by battle space informational footprint, or it could be civilians in the adversary terrain governed by pride to protect their country and cultural identity.* In this regard, Vygotsky (1978) notes that human cognition and decision-making develops in the species-specific medium of culture, which is an accumulated pattern of tool-use throughout the historical existence of a group. As shown in Exhibit 2.

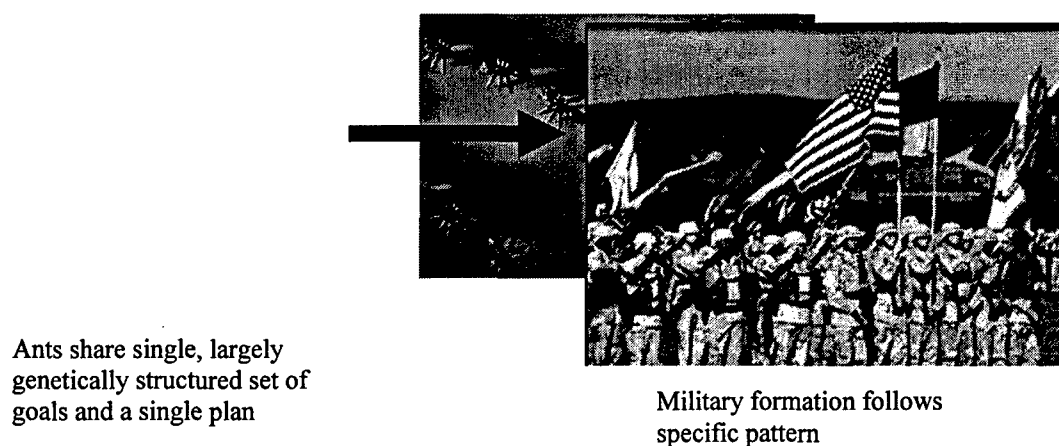


Exhibit 2: Culture as Analogies and Metaphors

CHAPTER 6

ANTICIPATED MODELING CONSTRAINTS

To be useful, a decision tool must help its user by providing relevant information that will ultimately factor into a decision. There are various ways in which a tool can help in designing a culturally-driven computer-based tool to support military training. When faced with the prospect of taking into account culture, as it pertains to conflict and coalition activity, there are three difficulties. First, cultural data varies widely. Sources of cultural data are unstructured, nuanced, and don't easily admit generalization from the contingencies particular to them. This chapter summarizes some of the anticipated problems for modeling cultural factors for military training.

6.1. Variations in Cultural Adaptability

ARL researchers under the lead of Dr. Linda Pierce¹² have identified barriers to adaptability in the training and knowledge components of military units preparing to transition to stability and support operations (SASO). In pre-deployment training exercises, a warfighting mindset interfered with learning how to conduct steady state operations in a peacekeeping environment. Other barriers to learning included the lack of meaningful participation by critical team members from civil affairs, the international community, and multinational forces and an inability to control the training events to insure that there were consequences for mistakes and to provide opportunities for the participants to correct errors and practice "what right feels like."

6.2. Danger of Skewed Distribution: Effect of Dominance Culture

The effects of power distance and other cultural elements given on Table 1 of this report can contribute to skewed statistical distributions for use in simulation modeling. Davis and Fu¹³ observe that some culture types are stronger than others dominating the results of teamwork and communication between individuals. These culture types are:

- National culture that is defined as a "collective mental programming" of the people of any particular nationality (Hofstede, 1980), (Hofstede, 1991), or as "inherited ethical habit" that can consist of an idea or value, or of a relationship.
- Organizational or corporate culture that covers many facets of organizational life, areas such as management styles, appraisals, rewards, and communication styles used by employees. Corporate culture may be strong for the group but weak for individuals.
- Professional culture that is ingrained through highly structured formal education during formative years and continued through training programs. This culture is reinforced through ongoing professional activities such as affiliation with associations. It is a strong culture related to

¹² Linda Pierce, et al., (2004). *Leader and Team Adaptability in Multinational Coalitions: Cultural Diversity in Cognition and Teamwork*. (Army Research Lab—HRED: Aberdeen Proving Ground)

¹³ Alex Davis & Dan Fu (2004). Culture matters: Better Decision making through Increased Awareness. *Interservice/Industry Training, Simulation, and Education Conference (I/ITSEC)*, paper # 1852.

organization culture since a person usually chooses one profession for life. Moreover, professional cultures cross over national cultures.

- Functional culture that is made up of those norms and habits associated with functional roles within the organization, such as marketing, R&D, and manufacturing.

6.3. Variations in Context Interpretation of Culture

An important question to the system analyst is, "What type of knowledge is the most effective in guiding the population component?" To answer this question, Dafoulas and Macaulay (2001) and Chung and Reynolds (1998) identify at least two basic categories of knowledge that are contextually co-varied: normative and situational. Normative knowledge provides standards for individual behavior and provides guidelines within which individual cultural adjustments can be made. Situational knowledge provides a set of exemplar cases that are useful for the interpretation of specific individual experience. An example of situational disparity is strategies used by the different ethnic factions in Iraq to gain control of their locality—terrain in the military parlance. In Iraq, while the common culture driven by Islam remains fundamental, there are different interpretations that lead to subcultures known by such names as fundamentalism and insurgencies.

6.4. Variations in Information Abstraction

Cultural information abstraction can also affect the system analyst representation of cultural factors in simulation and training software. As alluded to before, within the military hierarchy, cultural information can be abstracted to reflect the DIME and PMESII factors. This in turn plays out in the means-ends abstraction used for work domain as advocated by Rasmussen (1986) and commonly used as a design tool by software engineers. Here the abstraction differentiates team profile (diversity level), role profile (preference level) and task profile (requirements level). Dafoulas and Macaulay (2001) use Figure 10 below to illustrate the possible sources of information abstraction and variations. In addition to these high level work-domain abstract levels, there is also abstraction of the required skills such as motivation, decision and problem solving skills, conflict resolution, leadership, and communication skills. The performance measures are played out as cultural variables such as power distance, uncertainty avoidance, individualism, time, trust, space, and so on.

6.5. Verification, Validation, and Trust

How can the results of simulation be trusted? This is the question that must be answered in order to accept culturally-driven military models and simulations. Presently, there are no rigorous validation and verification guidelines for such simulation models. The current simulation systems are well matured and their methods generally follow "**perception-decision-action loop in cognitive modeling.**" However, with culture-based modeling, culture factors can be difficult to pin down in traditional models. For example, cultural considerations will constrain or expand the courses of action available to a person, but not predict which will be chosen. Although cultural factors may be ubiquitous, it is difficult to converge on an acceptable model of cultural influence.

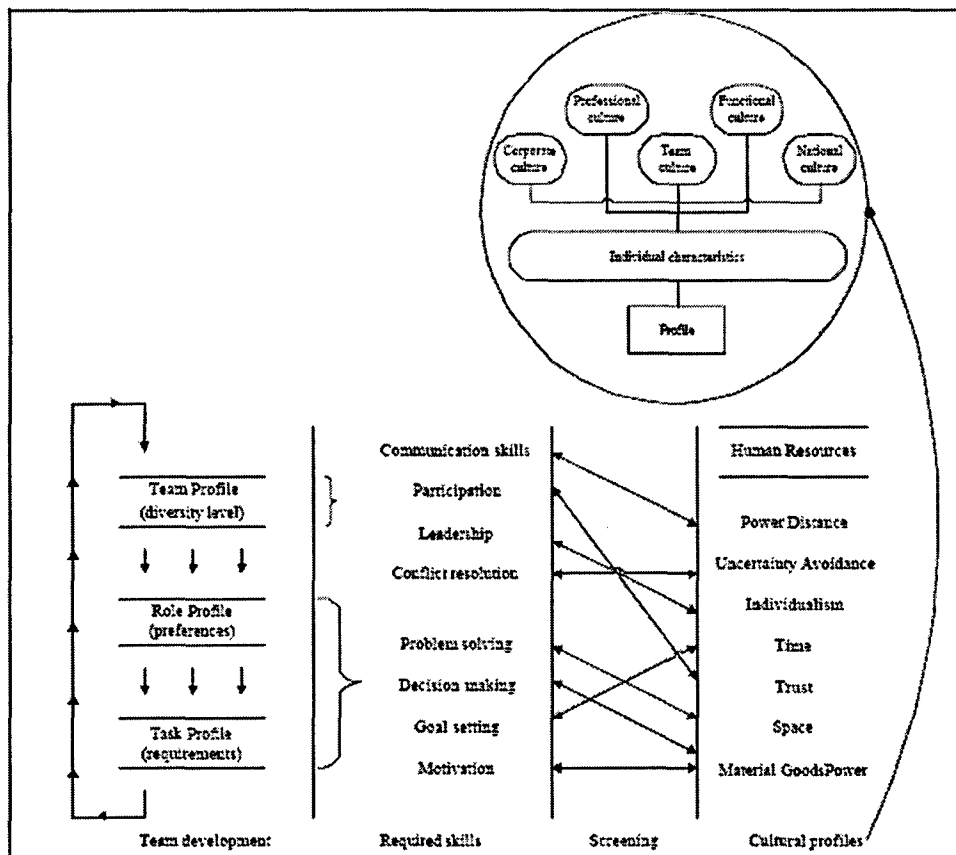


Figure 10. A Framework for Using Cultural Models Dimensions in Virtual Software Teams (Dafoulas & Macaulay, 2001)

CHAPTER 7

TOWARDS A PROOF-OF-CONCEPT SIMULATION MODEL

7.1. Background

Previous research in the business community has led to the development of simulation games based on the Hofstede model that have been used to enhance these generic intercultural skills. The general approach of this work is to arrange for teams of players, each adopting a different synthetic culture, to negotiate a pre-defined outcome with the other teams. The aim is to produce insight into cultural differences through interactions with others, and to develop skills for dealing with those differences through negotiation. The Simulations for Adaptability (Sfor Adapt), has been developed based on the adaptive learning model (Pierce, 2004). Mills and Smith (2005) identified adaptation- and cross-cultural communications-skills as the enabling factors relevant for simulation games on intercultural awareness. The purpose of the culture-based simulation games is to build trust and understanding between people of different cultures—and they are relevant in many ways to the military C2. Examples include: coalition formation, negotiation skills in making joint decisions, and the commander understanding of the adversary terrains. Gatherer (2002) identified at least five ways that can be used to simulate culture as a dynamics of evolving behaviors so as to capture evolving understanding in the context of changing cultural traits. These are,

- (1) **contagion** - where behavior can only be copied directly from one agent to another via social contact (simple 'echo' contagion of the behavioral variety - those authors' requirement that there should be non-intentionality is not relevant to software objects).
- (2) **via a common pool of cultural information** - an agent can select a behavior from a set of social norms, without coming into direct contact with another individual exhibiting that behavior.
- (3) **the 'contagionist paradigm'**, i.e.: the common sigmoid curve representation of a memetic epidemic is a very special case, requiring a fairly contrived set of system parameters in order to be produced.
- (4) **the 'random walk'**, i.e.: an apparently stochastic meandering of meme frequency over time, is the more likely situation, even when the underlying parameters are far from random - a frequent variation is a pseudo-random walk around an equilibrium level.
- (5) **a population with a high turnover of agents** (and hence a high proportion of naïve agents at any one given time) cannot maintain either of the described behaviors, rational or irrational, i.e.: those meme frequencies drop to zero, without recourse to the use of a cultural information pool.

7.2. Developing a Proof-of-Concept, Plug-and-Play Simulation Model of Cultural Dynamics: Supporting Theories

Current analytic models derived for culture-based simulation tend to focus on a single level of a decision hierarchy (for reviews, see Lumsden & Wilson, 1981; Prietula, Carley, &

Gasser, 1998; Sandoe, 1998). Handley and Levis (1992) have presented a conceptual model for culture simulation based on Hofstede's (1980, 1991) power dimensions of organization by using Koomen's (1985) information theoretic model and Petri network representation. The other most commonly use method is based on the concepts of cultural selection theory (Fog, 1990) and dual inheritance theory (Gatherer, 2002). Cultural selection theory is a theory about phenomena which can spread in a society- such as a religious ritual, a genre of art, or a certain fishing method. The theory entails three basic processes. First the phenomenon has to arise. This is called innovation. Next, the phenomenon may spread from one human to another or from one group of humans to another. This is called reproduction, transmission, imitation, or diffusion. The third fundamental process in the theory is selection. By selection we mean any mechanism or factor that has an influence on how much or how little the phenomenon will spread. The most obvious kind of selection is the conscious choice exerted by humans. Cultural selection theory explains why certain cultures or cultural elements spread, possibly at the expense of other cultures or cultural elements which then disappear (Garfinkel, 1967). Cultural elements include social structure, traditions, religion, rituals, art, norms, morals, ideologies, ideas, inventions, knowledge, technology, etc.

Dual inheritance theorists accept that since culture exhibits the three characteristics required for evolution by natural selection — variation, heritability, and fitness effects — cultural evolution can be analyzed in a neo-Darwinian fashion (Reynolds, Whallon, & Goodhall, 2001). However, since cultural inheritance differs from genetic inheritance in fundamental ways — including non-parental transmission and multiple transmission events over a lifetime — they tend to view the evolutionary dynamics of culture as different from biological evolution. Also, genetically non-adaptive cultural evolution is not only possible, but likely if the differences referred to are most marked, such as in modern bureaucratic societies (Veiga, Lubatkin, et al., 2000).

Both cultural selection theory (CST) and dual inheritance theory (DIT) are based on evolutionary models of Dawkins (1982). Dawkins's cultural evolutionary model assumes that (a) Culture is made up of specific units (such as Dawkins' "memes"); (b) These units replicate themselves with occasional variations; and c) Some process of selection among these variations is the main force driving cultural evolution. A meme is a culturally transmitted unit of information analogous to the gene (Dawkins, 1982). A meme is not a form of life, and thus, cannot reproduce itself; it can only influence people to replicate it.

7.3. Genetic Algorithms

Genetic algorithms (GA) take their constructs from biological models and probabilistic reasoning (see, e.g., Holland, 1992; Goldberg, 1989). GA operates by using an initial population of information about object behaviors. Examples are birth-death process in queuing theory or initial conditions in time-based optimization problems. This initial (and subsequent) behavior or state of nature of the system can be represented as bit strings, with each bit taking binary values of "1" or "0", based on the evolving state of the system. The solution with high fitness (using a function designed to optimize outcome) are mated with other solutions by crossing parts of a solution string with another. Solution strings are also mutated similar to the death process. Over time, the operations of weeding out poor fitness solutions and reproducing by crossing high fitness solutions at random points act to randomly sample a large part of the state space the system behaviors.

GAs search solution spaces by recombining and maintaining useful schema (or building blocks) in the population. Each population member samples the entire possible schema to which its bits belong. GAs is appropriate for stochastic, non-linear problems such as cultural dynamics that is, evolving nature of human culture (Rentsch, Hefner, and Duffy, 1994). This concept has been exploited to model culture either purely from GA view point (Reynolds, Whallon, and Goodha, 2001) or its invariants, such as memetics (Fog, 1990).

Some of the advantages of GA are (Ji and Zhang, 2001):

- 1) **Autonomy:** GA does not require initial guess. The initial parameter set is generated randomly in the predefined parameter domain.
- 2) **Robustness:** GA works with a rich population and simultaneously generates optimal solution during the search process without getting trapped at a local minimum.
- 3) **Noise Immunity:** GA searches a fit parameter set and moves towards the global optimum by reducing the chance of reproducing unfit parameter sets.

There are three basic genetic operations in GA. These are a) evaluation; b) selection; and recombination.

Evaluation: In this operation, each string which encodes a candidate solution is evaluated based on a fitness function. This corresponds to species surviving in an environment.

Selection: This is the process of selecting a candidate solution based on its relative fitness. At least two candidate solutions are then chosen for further exploration (reproduction). Selection serves to focus search into areas of high fitness.

Recombination: This is the process of perturbing the current solution via mutation, imitation, and crossover techniques. Crossover algorithms allow for random information exchange between candidate solutions by copying codes from parent population and replacing them with another genetic string in a second parent population at the crossover point.

Mathematically, crossover follows that

$$C_{\text{new}} = \alpha p_i + \beta p_j \quad (1)$$

Where, p_i and p_j are the parent individuals from the last generation (or iteration);

C_{new} is the new individual in the current generation; α and β are the proportion of good alleles (a gene that exist at a single gene position), which may be probabilistically inherited from p_i and p_j .

Mutation takes place after crossover operations. The mutation operator introduces new genetic structures in the population by randomly changing some of its building blocks, thus helping the optimization procedure to escape local minima traps.

In summary, the operation of the basic GA can be outlined as follows:

- 1) Generate random population of n chromosomes (chromosomes consist of a linear end-to-end arrangement of genes).
- 2) Evaluate the fitness of each chromosome x in the population.
- 3) Select two parent chromosomes from a population according to their fitness.

- 4) With a crossover probability cross over the parents to form a new fitness.
- 5) With a mutation probability mutates new offspring.
- 6) Place new offspring in a new population.

7.4. Model Representation

The binary representation scheme of genes is one commonly used. But real number presentation is also used because it needs no transformation of the number systems. For our problems, the genes consist of n cultural variables (obtained from Table 1 of Chapter 1), which are natural for the real number presentation. Here, a cultural trait is perceived as an object with n genes (properties).

Fitness Function and Selection

The fitness function and selection strategies are important in creating the next generation population. The common approach to selecting a generation strategy is the proportion based on roulette wheel defined by

$$P(j) = F(j) / \sum (F(k), k = 1, 2, \dots, N) \quad (2)$$

Where, $P(j)$ is the selection probability accorded individual j . The individual with a better fitness function is selected with a higher probability. To produce a child s , $s = 1, 2, \dots, N$, of the next generation, define $S(j) = P(1) + P(2) + \dots + P(j)$, $j = 1, 2, \dots, N$. Then generate a random number $\xi \in U(0,1)$, the uniform distribution on $(0,1)$. If $S(j-1) < \xi \leq S(j)$, the individual j is selected as the parent of child s . Thus, a child will be produced by mutation along a weighted gradient direction from individual j . In general, the strategy selected here integrates the concepts of natural selection and adaptation with existing cultural parameters. Each chromosome in the population is reproduced a number of times proportional to its objective function value.

The fitness function for selecting a chromosome is given by Equation 3 as

$$f(x) = \frac{1}{1 + |A - BX|^{1/k}} \quad (3)$$

where A is the original strength of individual culture and its domain ranges from zero to infinity; B is the slope or rate of discernment of the culture and its domain ranges for negative infinity to positive infinity; k is the chromosome length; and $X \in (0,1)$. A valid chromosome for this simulation is given in Exhibit 3.

Culture A																	
Power I-C	UA	Gender	Nature	Time	Human	behavior	Global	Relation	Ego	Status	Values	Norms	Beliefs	religion	Values	Beliefs	Norms
1	0	1	1	1	1	0	1	1	1	0	0	1	1	1	1	0	1

Culture B																	
Power I-C	UA	Gender	Nature	Time	Human	behavior	Global	Relation	Ego	Status	Values	Norms	Beliefs	religion	Values	Beliefs	Norms
0	0	1	0	1	1	0	0	1	0	0	1	1	0	0	0	1	1

Exhibit 3. Sample Culture Chromosomes

7.5. The Simulation Game

The goal of the simulation game is to determine a time epoch when at least two cultures (say A and B) can attend a stable cultural affinity—that is, tend to understand each other's culture through a process of incremental learning.

Hardware Requirement:

To use the Genetic Algorithm Culture software, you need the following:

1. PC with Pentium IV processor
2. Windows 2000 or XP operating system
3. 64MB RAM or higher
4. The PC must have access to the internet.

Software Requirement:

The following application software needs to be installed on the PC in order to successfully run the GA Culture Application Software:

1. Microsoft XP professional operating system
2. Matlab

Installation of GA Culture Application Software

We recommend that the GA Culture Application Software be copied to a thumb drive and be used as a stand alone software at this time. However, it may be copied to the hard drive.

Running GA Culture Application Software:

To run the application software, follow the following directions:

1. Click the <START> button on your desktop
2. Select Programs
3. Select Matlab
4. Once the Matlab program loads (Exhibit 4), select the FILE from the menu bar

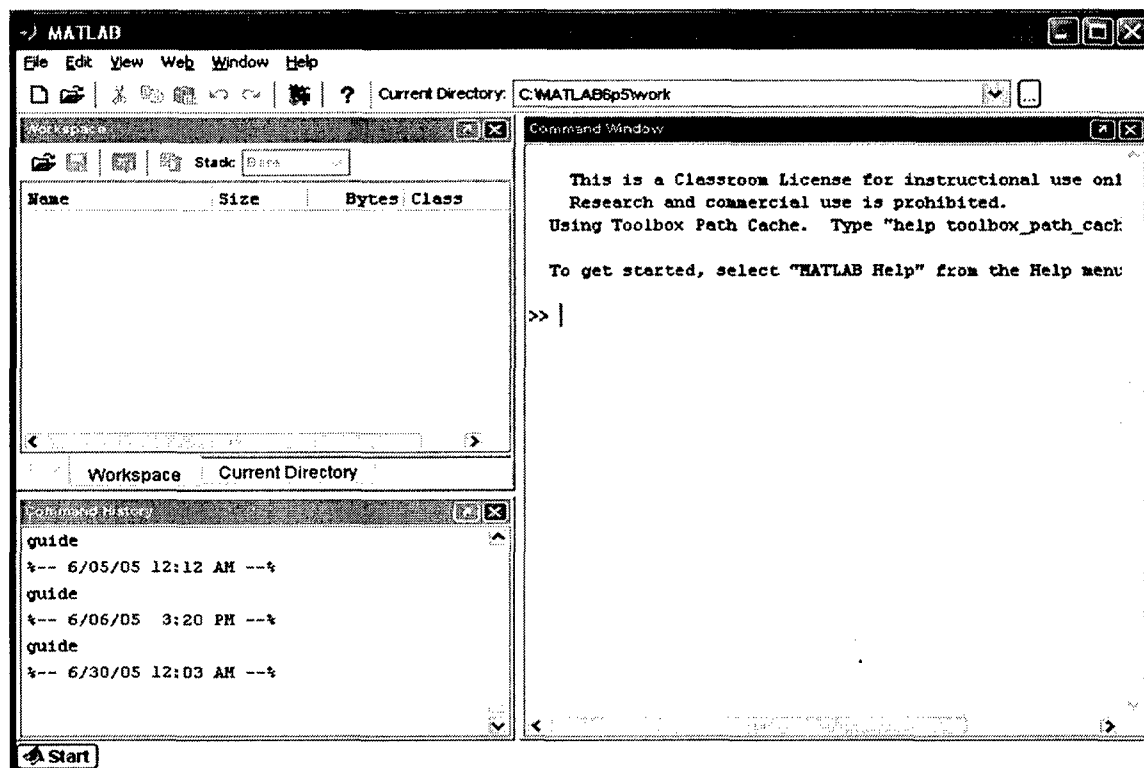


Exhibit 4. Matlab Interface

5. Select the menu option OPEN
6. Navigate to the drive where the thumb drive is, select the CultureHCI.m file and click <OPEN> button (Exhibit 5).

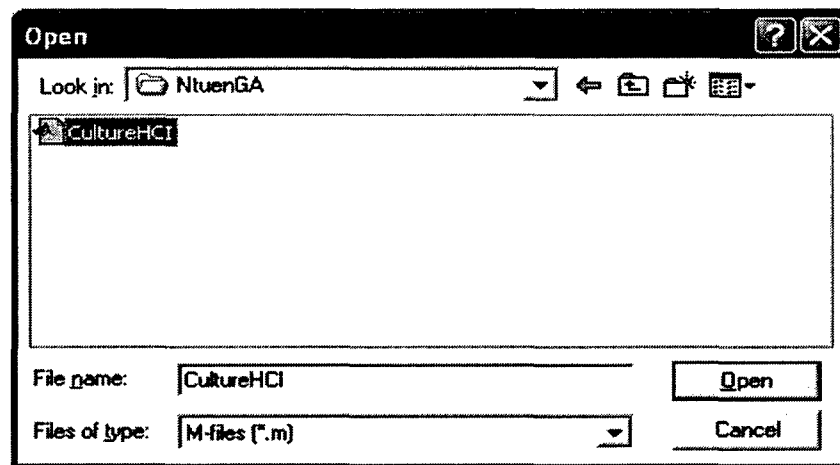


Exhibit 5. Open Dialog Box

7. The code of the software opens in Matlab (Exhibit 6).

```

1 function varargout = CultureHCI(varargin)
2 % CULTUREHCI M-file for CultureHCI.fig
3 % CULTUREHCI, by itself, creates a new CULTUREHCI or raises the existing
4 % singleton*.
5 %
6 % H = CULTUREHCI returns the handle to a new CULTUREHCI or the handle to
7 % the existing singleton*.
8 %
9 % CULTUREHCI('CALLBACK',hObject,eventData,handles,...) calls the local
10 % function named CALLBACK in CULTUREHCI.M with the given input arguments.
11 %
12 % CULTUREHCI('Property','Value',...) creates a new CULTUREHCI or raises the
13 % existing singleton*. Starting from the left, property value pairs are
14 % applied to the GUI before CultureHCI_OpeningFunction gets called. An
15 % unrecognized property name or invalid value makes property application
16 % stop. All inputs are passed to CultureHCI_OpeningFcn via varargin.
17 %
18 % *See GUI Options on GUIDE's Tools menu. Choose "GUI allows only one
19 % instance to run (singleton)".
20 %
21 % See also: GUIDE, GUIDATA, GUIHANDLES
22
23 % Edit the above text to modify the response to help CultureHCI
24
25 % Last Modified by GUIDE v2.5 04-Jun-2005 18:46:18
26
27 % Begin initialization code - DO NOT EDIT
28 gui_Singleton = 1;
29 gui_State = struct('gui_Name',       mfilename, ...
30                   'gui_Singleton',   gui_Singleton, ...
31                   'gui_OpeningFcn', @CultureHCI_OpeningFcn, ...
32                   'gui_OutputFcn',  @CultureHCI_OutputFcn, ...
33                   'gui_LayoutFcn',  [], ...
34                   'gui_Callback',    []);

```

Exhibit 6. GA Culture Application Software Code

8. On the menu bar, select the Debug menu and then run. The Matlab editor dialog box opens (Exhibit 7). Click OK button to continue.

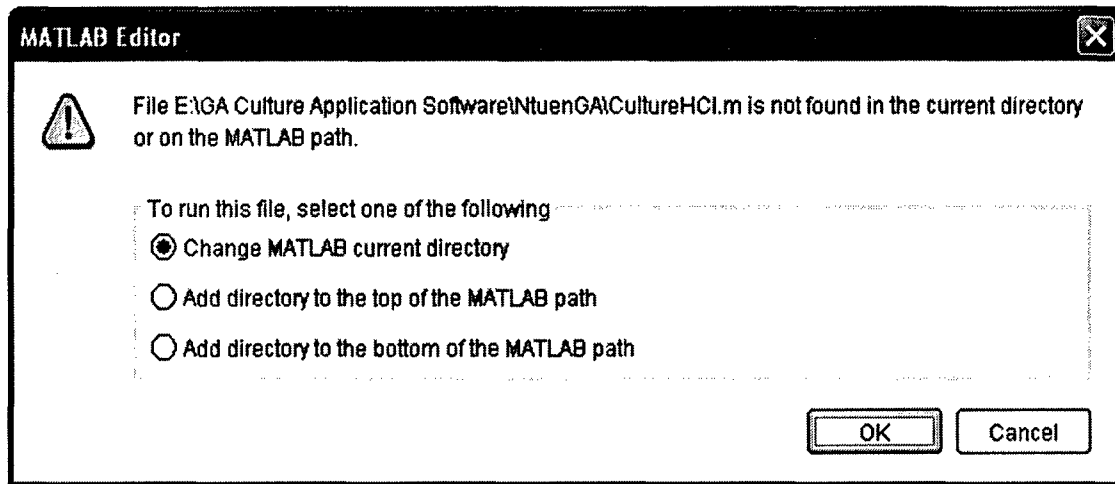


Exhibit 7. Matlab Editor Dialog box

9. The user interface (Exhibit 8) below appears and the program is ready to be used.

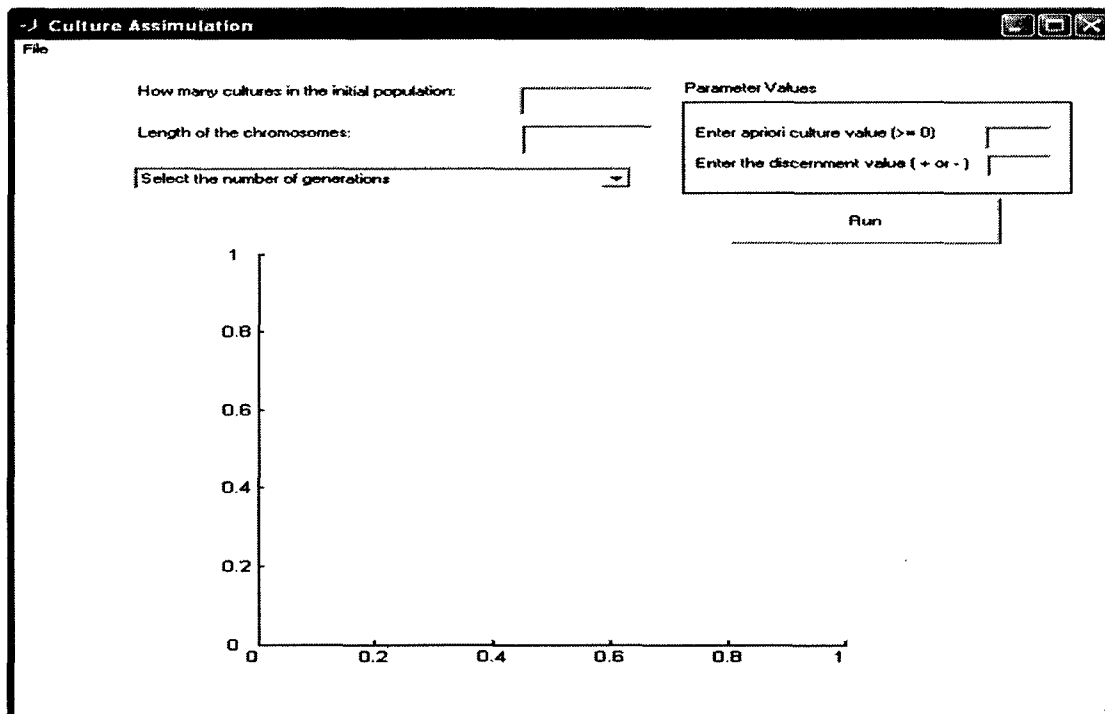


Exhibit 8. CultureHCI Interface

Getting Started

The CutureHCI interface consists of the following parts:

- Definition of the number of cultures in the initial population.
- The chromosome length
- Selection of the number of generations to run
- Definition of parameters for the fitting function
- The run button
- The graphical display area

Definition of the number of cultures in the initial population

The number of cultures in the initial population must be at least 2. This is because the reproduction phase of genetic algorithm requires two parents in order to produce offspring. Technically, there is no limit on the size of the initial population.

The chromosome length

The chromosome length depends on the number of criteria that defines the chromosome. For example, the gender criterion requires two possible outcomes, male or female. This can be represented using one bit in the length of the chromosome.

Selection of the number of generations to run

A set of predetermined number of generations has been included in the pull down combo box. The higher the number the longer it takes for the software to reach an optimal solution.

The run button

Once the population size, length of the chromosome, parameter A and B have been defined, click the run button to execute the program. The program executes for a while and displays the average (green) and maximum (red) fitness of the population for each generation. Below is a sample run (Exhibit 9)

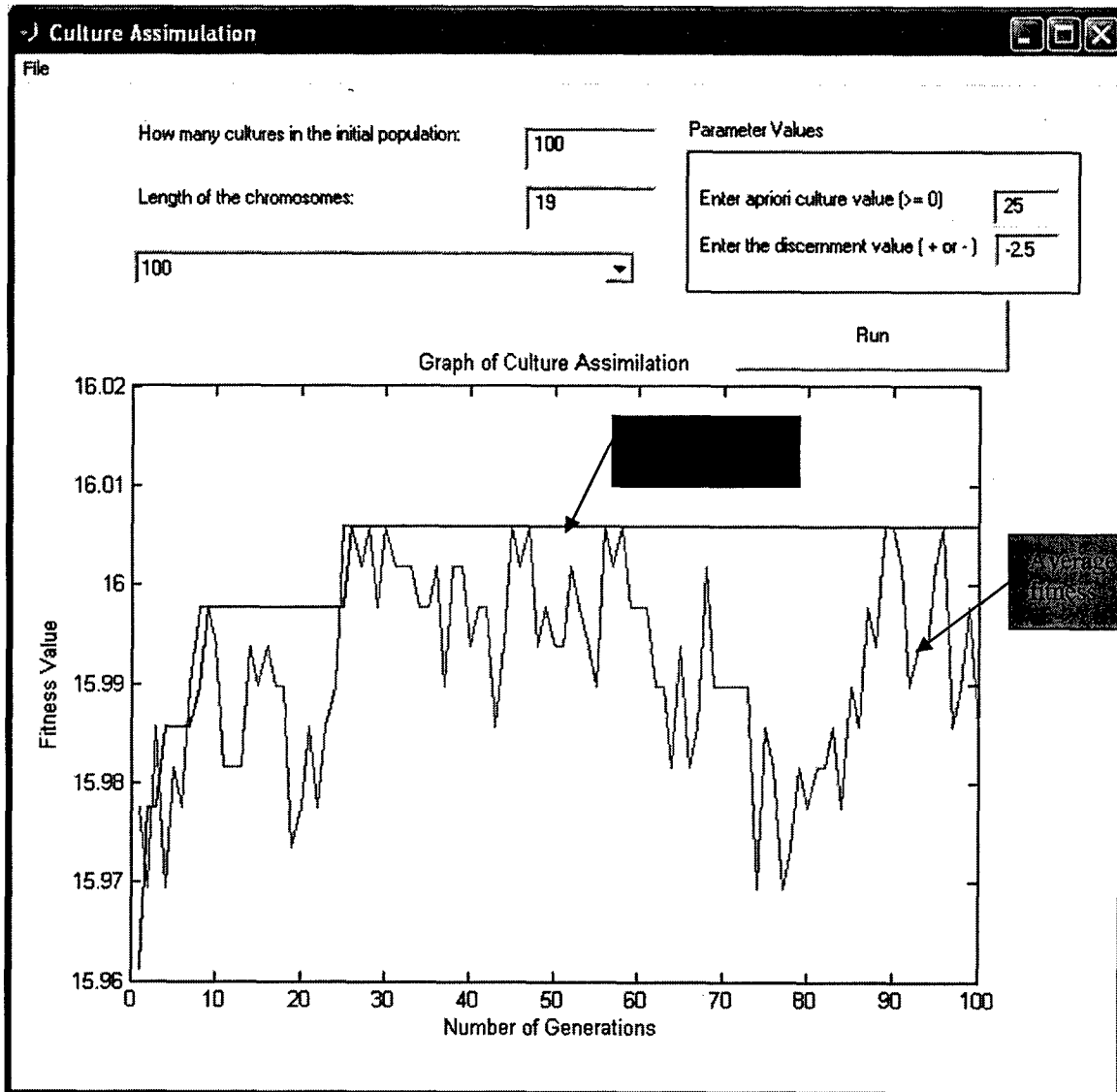


Exhibit 9. Sample Run for 100 Cultures with 19 Chromosomes

CHAPTER 8

CONCLUSIONS AND OBSERVATIONS

This technical report has focused on an anecdotal review of cultural factors and their implications for military modeling and simulation. Changes in modern warfare that include its asymmetric nature and coalition forces were addressed. The following are observations and conclusions based on the existing literature in the topical areas:

8.1. General

- Culture influences cognitive fundamentals for teamwork, such as communication, coordination, and decision-making (Bowman & Pierce, 2004).
- US Forces are not fully prepared to meet the unique requirements of peacekeeping missions and lack of skill in multinational teamwork is a specific barrier to effective performance (Klein & Pierce, 2001; Pierce & Pomranky, 2001).
- Cultural traits are responsible for the conflicts among the styles of performance of EBOs and C2 in modern warfare systems.
- Language and communication are the major drawbacks in plan integration and in most logistical problems. Understanding a common operating picture of JTF demands near realism and congruency in signs, signals, and symbols. These factors are important in the development of common interface architecture for simulation and war game software systems.
- Organizational barriers to teamwork are the result of national military strategies and processes.
- Lack of cultural awareness: Understanding the culture of team members and the country of service are crucial for decision-making.
- Overall, conflicts within groups are unrelated to demographic variables such as age, ethnicity and gender, but these differences are related to the values among group members (McGurk, Thomas, & Bliese, 2002).

8.2. Influence on Military C2

Coalition Cultural Factors:

Individual Differences:

- Information processing and cognitive ability—pace, accuracy, and so forth
- Personality styles: introvert, extrovert—concrete vs. conceptual thinkers
- Behavior such as response to anomalies, chaos, uncertainties, and so forth
- Perception of situation: interpretation & understanding

Coalition Organization differences:

- Chain of command
- Command & control: command intent, authority, command styles
- Organizational policies
- Concept of mission

- Variants in strategy, operation, and tactics
- When values are shared, there is a built-in tendency to work with the same operating system.
- Organizational theorists tend to believe that, regardless of the type of design structure, cultures emerge from organizational designs (Colby, 2003). Hofstede's (1980, 1991), Kluckhohn and Strodtbeck (1961), and Schein (1992) have independently identified power dimensions as the main sources of unhealthy organizational management. Team interaction mental model and situation awareness (SA) have also been investigated, and results show that both provide information concerning the roles, responsibilities, communication patterns, and interactions among team members (Converse, Cannon-Bowers, and Salas, 1991; Endsley and Pearce, 2001).

8.3. Simulation and Modeling Applications

- Mathematical models of culture are too minimal to cope with the open-ended diversity of culturally derived information (variation is generally restricted to trial and error learning or transmission error).
- There are numerous intra-individual factors that undoubtedly have emergent inter-individual consequences, such as how representations are grounded in experience and how they are stored, retrieved, and implemented. Models of individual intelligence and creativity, on the other hand, lack transmission and replication.
- Culture is heterogeneous when people of various backgrounds interact with one another. It is homogeneous when people share common beliefs, attitudes, and values. Although belief and values can be common in an organization, its function or purpose can vary from division to division, department to department, workgroup to workgroup, and individual to individual. Different sub-cultures, therefore, emerge from, or form around, functional groups, hierarchical levels and corporate roles, with very few values, beliefs, attitudes or behaviors commonly shared by the whole corporate membership. On the basis of this evidence, mathematical models have been used to represent behaviors in these organizations (Sandoe, 1998). The complexity of layered representation based on military hierarchy design and command level interaction remains a fertile area of research.

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